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PRECISION CLEANING AND VERIFICATION PROCESSES USED AT MARSHALL SPACE FLIGHT CENTER
FOR CRITICAL HARDWARE APPLICATIONS

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1. INTRODUCTION

BACKGROUND

Marshall Space Flight Center Operations and Responsibilities

- Propulsion
- Microgravity Experiments
- International Space Station
- Space Transportation System
- Advance Vehicle Research

MSFC ORGANIZATION

- Center Organization
- Science & Engineering Directorate
- Materials and Processes Laboratory
 - Fabrication Services Division
 - Cleaning Services)
 - Project and Environmental Engineering Division
 - (Chemistry, Verification Testing)



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2. "SPECIFICATION-DRIVEN" CLEANING AT MSFC

- MSFC-SPEC-164a, Cleanliness of Components for Use in Oxygen, Fuel & Pneumatic Systems, specifies CFC 113 and Trichloroethylene (TCE) and Trichloroethane (TCA) for precision cleaning, field cleaning and as the cleanliness verification test solvent for Nonvolatile Residue (NVR) and particulate analysis.
- MSFC-SPEC-164a is applied to MSFC fabrication and testing activities and is a contract requirement for Space Shuttle propulsion elements:
 - External Tank (ET)
 - Space Shuttle Main Engine (SSME)
 - Alternate Turbopump Development (ATD) and Production
 - Solid Rocket Booster (SRB)
- MSFC-SPECT-164b supersedes MSFC-SPEC-164a as of November 1994. This revised specification is "performance based" versus "how to" and provides for alternative cleaning/verification methodologies and media. However, replacements must be base-lined to CFC-113. It does not address the aspect of CFC-113 not being available.
- Trichloroethylene (TCE) is a replacement for CFC-113 in specification (Engineering Requirements) driven cleaning applications at MSFC. Trichloroethylene is not necessarily the alternative for MSFC Shuttle contractors.



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3. CLEANING FACILITIES

- “Rough Cleaning”, Metal Treating and Electro-Plating (Figures 1, 2, 3, 4)
- Precision Cleaning (Figures 5, 6, 7, 8, 9)
- Verification Testing Laboratory (Figures 10, 11, 12)

4. CLEANING PROCESSES

- Liquid Oxygen, Fuels and Pneumatic Systems (MSFC-SPEC-164b)
- Manufacturing Procedure for Vapor Degreasing of Metallic Surfaces-
Tetrachloroethylene (Perchloroethylene) MP206
- Cleaning Procedure for Low Strength Steel & Steel Alloy, High Strength Steel & Alloy
& Aluminum Alloy MP200
 - Vapor Degrease - Handwipe - Sand Blast (as necessary)
 - Alkaline bath-Turco 4215***
 - Etch - Caustic Solution
 - Acid Bath
 - Electro-Clean (Turco Surj.)***
 - Deoxidizing Solution - Turco Smut-go 1***
 - DI Water rinse - Hot & Cold
 - Forced High Purity Air Dry

*** TURCO is a registered trademark of Elf Aquitaine, Inc.



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• Component Cleaning

- Non-Lox Service
- Optics
- Film
- Flow Meters
- Electronics
- Load Cells
- Ball Bearing Testers
- Computer Electronics
- Photographic Components

5. VERIFICATION TESTING

- Non-volatile Residue (NVR) determination by gravimetic procedure
- Particulate count by microscopic visual examination
- NVR & Particulate Procedure base-line with CFC-113 solvent

6. CFC-113 REPLACEMENT FOR VERIFICATION TESTING

- ODC Solvent Study at MSFC
 - CFC-113 - Isopropyl Alcohol - Trichloroethylene - AK225* - Verteil MCA**
- Trichloroethylene (TCE) was selected for use at MSFC. Significant data base exists from Saturn to Shuttle which supports the implementation of TCE as an alternate verifications solvent.

* AK225 is a registered trademark of ASAHI Glass Co., Ltd.

** Verteil is a registered trademark of DuPont



- Advantages of TCE
 - Short atmospheric lifetime
 - Non-ODC
 - Cost is many times less than other alternate solvents
 - No foreseeable punitive taxation/restrictions
 - Removed from list of potential carcinogens per ACGIH and MSDS
 - Very small volume used (Only for NVR and Particulate)
- Disadvantages of TCE
 - Hazardous Air Pollutant (HAP)
 - Water & Ground Pollutant
 - Associated Toxicity Problems
 - OSHA PEL = 50 ppm
 - MSFC PEL = 25 ppm
- TCE Implementation - Guidelines & Precautions
 - Minimize solvent usage for cleanliness verification
 - Assure material compatibility
 - Special handling procedures to protect personnel & equipment
 - Containment barriers to protect groundwater
 - Personnel protective equipment
 - Personnel Training



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- Safe Handling procedures
 - Emergency procedures in-place
 - Adequate air handling system
 - 25 ppm maximum PEL
 - Filtered make-up air
 - Exhaust scrubbers as required

7. ALTERNATE CLEANING AND VERIFICATION STUDIES

- Critical Cleaning Evaluation and Implementation for Chlorofluorocarbon Replacement
Study by CH2M Hill Southeast, INC. for the Environmental Engineering and Management Office, Marshall Space Flight Center
 - Task 1 Printed Wire Board Acceptance
 - Task 2 CFC Distillation Implementation
 - Task 2A Development of a Pharmacy System Concept
 - Task 2B Alternatives to ODS Cleaning
 - Task 3 Alternative CFC Cleaning for TBE
 - Task 4 Transition from CFC-113 for Engine Test Activities
 - Task 5 Evaluation of an Alternative Cleaner for Ion Pumps
 - Task 6 Implementation Status of Non-ODS Alternative Recommendations
 - Task 7 Development of Air Emissions Data for ADEM Fee Assessment
- CFC-113 Replacement Project By Daniel E. Adams, Mechanical Systems Test Branch, Propulsion Laboratory (Handwipe cleaning replacement study for CFC-113)



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8. CONCLUSION

- CFC-113 usage (Cleaning - Verification) at MSFC has reduced from 64,000lbs.(CY93) to 30,000lbs.(CY94) to close to zero in 1998. Remaining stock re-distilled for very special requirements.
- MSFC will utilize TCE as an interim replacement for CFC-113 for Verification testing.
- The MSFC-managed Space Shuttle contractors are providing "lessons learned" for implementation of aqueous and semi-aqueous cleaning.
- MSFC will continue to use the perchlorethylene degreasing solution. The current cleaning processes are essentially water-based. Chromate solutions will be replaced with no-chromate solutions.
- Studies are planned for maximizing use of aqueous cleaning and water verification